Glen Canyon Dam Adaptive Management Program Information Needs In Sequence Order

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This document contains the Information Needs of the Glen Canyon Dam Adaptive Management Program in two formats. The first section, starting on page 2, contains a list of the Information Needs (INs) in sequence order, from Sequence Order 1 through Sequence Order 11.5. The second section, starting on page 15, lists the same INs with their sequence order, this time organized in numerical order by goal.

In addition, both lists include the category into which the Glen Canyon Dam Adaptive Management Work Group (AMWG) placed each IN. The key to the categories, as approved by AMWG in January 2003, is as follows:

Category A: INs that are appropriate for funding by power revenues and for accomplishment by the Grand Canyon Monitoring and Research Center (GCMRC).

Category B: INs that may be addressed by the GCMRC but are not appropriate for funding by power revenues.

Category C: INs that are funded and accomplished under the authority of an entity other than the GCMRC.

The INs, their categories, and their sequence order were developed through an iterative process that involved the GCMRC, the Technical Work Group (TWG), and two ad hoc committees of the AMWG: the Ad Hoc Committee on the Strategic Plan and the Ad Hoc Committee on What's In and Out of the Strategic Plan. The TWG finalized its work on the sequence order of the INs in November 2002. The Adaptive Management Work Group approved the INs as shown in this document on August 13, 2003.

Only Research INs (RINs) and Supporting INs (SINs) were sequenced in this exercise. All Core Monitoring INs were viewed as being equally important, and Effects INs were seen as duplicative of other INs.

The number of Information Needs that fell into each sequence order number is shown in the chart below. In the chart, for simplicity, the number of Information Needs in sequence order 1 and 1.5, those in 2 and 2.5, and so on, have been combined.
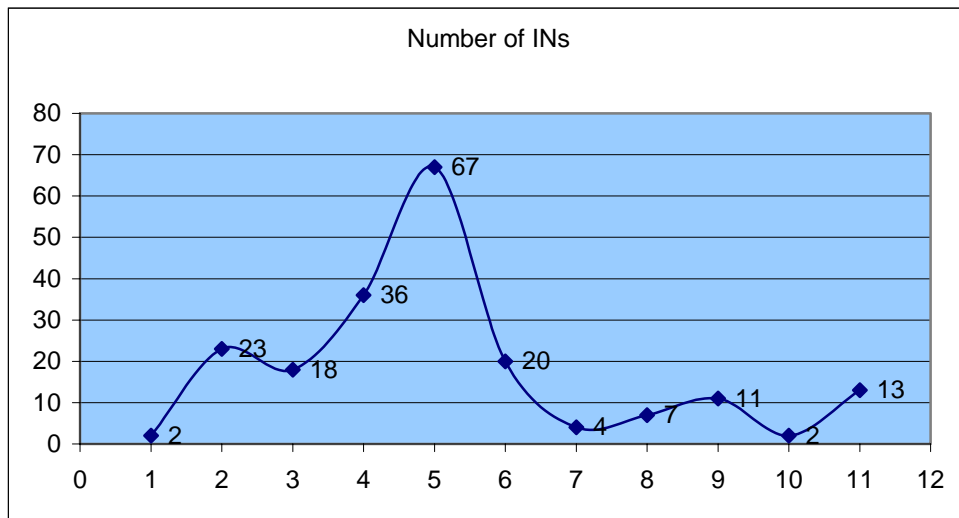
Information Needs in Sequence Order
As approved by AMWG on August 13, 2003

Sequence Order 1
(1 Information Need)

RIN 2.1.2 Quantify sources of mortality for humpback chub < 51 mm in rearing habitats in the LCR and mainstem and how these sources of mortality are related to dam operations. (Category A)

Sequence Order 1.5
(1 Information Need)

RIN 2.1.3 What is the relationship between size of HBC and mortality in the LCR and the mainstem? What are the sources of mortality (i.e., predation, cannibalism, other) in the LCR and the mainstem? (Category A)

Sequence Order 2
(15 Information Needs)

RIN 2.1.4 What habitats enhance recruitment of native fish in the LCR and mainstem? What are the physical and biological characteristics of those habitats? (Category A)

RIN 2.1.5 Determine the timing and quantity of young-of-year humpback chub dispersal (passive and active) from the LCR. (Category A)

RIN 2.2.3 What are the measurable criteria that need to be met in order to remove jeopardy for humpback chub in the Colorado River ecosystem? (Category C)

RIN 2.2.5 What are the appropriate habitat conditions for HBC spawning? Where are these found? Can they be created in the mainstem? (Category A)

RIN 2.2.8 What combination of dam release patterns and non-native fish control facilitates successful spawning and recruitment of humpback chub in the Colorado River ecosystem? (Category A)

RIN 2.2.9 What is the appropriate role of humpback chub augmentation as a management strategy to establish mainstem spawning aggregations? (Category A)

RIN 2.3.2 How will warming mainstem temperatures affect the abundance and distribution of parasites/disease? (Category A)

RIN 2.4.1 What are the most effective strategies and control methods to limit non-native fish predation and competition on native fish? (Category A)

RIN 2.4.3 To what degree, which species, and where in the system are exotic fish a detriment to the existence of native fish through predation or competition? (Category A)

RIN 2.6.1 What is a viable population (flannelmouth sucker, bluehead sucker and speckled dace)? (Category C)

RIN 2.6.2 What are the significant threats to these species (flannelmouth sucker, bluehead sucker and speckled dace)? (Category A)

RIN 4.2.6 To what extent are RBT below the Paria River predators of native fish, primarily HBC? At what size do they become predators of native fish, especially HBC, i.e. how do the trophic interactions between RBT and native fish change with size of fish? (Category A)

See page 1 for the key to the categories.

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RIN 5.2.2 How does the size and quality of the habitat used by Kanab ambersnail change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? (Category A)

RIN 12.9.2 What is the best combination of dam operations and other management actions to achieve the vision, mission, goals, and objectives of the GCDAMP? (Category A)

RIN 12.9.3 What are the relationships between dam operations and other management actions in their effects on resources addressed by GCDAMP management objectives? (Category A)

Sequence Order 2.5
(8 Information Needs)

RIN 2.1.1 What is the minimum population size of HBC that should be sustained in the LCR, to ensure a viable spawning population of HBC in the LCR? (Category A)

RIN 2.2.4 What is the relationship between the "aggregations" in the mainstem and LCR? Are mainstem aggregations "sinks" of the LCR? Are aggregations real or due to sampling bias? (Category A)

RIN 2.4.2 Determine if suppression of non-native predators and competitors increases native fish populations. (Category A)

RIN 2.4.6 What are the population dynamics of those non-native fish that are the major predators and competitors of native fish? (Category A)

RIN 4.2.1 What is the rate of emigration of rainbow trout from the Lees Ferry reach? (Category A)

RIN 4.2.2 What is the most effective method to detect emigration of rainbow trout from the Lees Ferry reach? (Category A)

RIN 5.1.5 What is the taxonomic identity of the Oxyloma snails at Vasey's Paradise? Is a change to the existing taxonomic status warranted? (Category C)

RIN 5.1.6 What is the range of occurrence of the ambersnail taxon found at Vasey's Paradise? [NOTE: Intended to address the issue of whether this is an endemic population or a relict population or part of a metapopulation.] (Category C)

Sequence Order 3
(13 Information Needs)

RIN 1.5.3 How has the value and availability of drift as a food source for Humpback chub changed with the implementation of Record of Decision operations? (Category A)

RIN 2.2.7 Determine if implementation and operation of the TCD and/or steady flows represent a technically feasible, ecologically sustainable, and practical option for establishing mainstem spawning. (Category A)

RIN 2.2.10 What techniques are available to determine natal stream of fishes in the Colorado River ecosystem? (Category A)

RIN 2.2.12 What are the impacts of research activities on mortality, recruitment, and the population size of humpback chub? (Category A)

See page 1 for the key to the categories.

RIN 2.3.1 How do parasite/disease loads affect population viability? (Category A)

RIN 2.4.4 What are the target population levels, body size and age structure for non-native fish in the Colorado River ecosystem that limit their levels to those commensurate with the viability of native fish populations? (Category A)

RIN 2.4.5 What are the sources (natal stream) of nonnative predators and competitors? (Category A)

RIN 5.1.9 How can incidental take for Kanab ambersnail at Vasey's Paradise be minimized? (Category A)

RIN 7.1.3 What are the potential ecological effects of increasing mainstem water temperatures? (Category A)

RIN 7.4.4 How does flow rate and fluctuation affect habitat availability and utilization by fish and other organisms? (Category A)

RIN 11.1.3 What are the thresholds triggering management actions? (Category A)

IN 12.1 Develop information that can be used by the TWG, in collaboration with GCMRC, to establish current and target levels for all resources within the AMP as called for in the AMP strategic plan. (Category A)

RIN 12.9.1 What is the impact on downstream resources of short-term increases to maximum flow, daily fluctuations, and downramp limits? (Category A)

Sequence Order 3.5
(5 Information Needs)

RIN 2.2.1 What is a viable population and what is the appropriate method to assess population viability of native fish in the Colorado River ecosystem? What is an acceptable probability of extinction over what management time period for humpback chub throughout the Colorado River ecosystem? (Category A)

RIN 2.3.3 How does non-native fish control affect disease/parasite loads? [Note: The concept is if there are fewer hosts, there will be a lower incidence of parasites.] (Category A)

RIN 4.2.7 What dam release patterns most effectively maintain the Lees Ferry RBT trophy fishery while limiting RBT survival below the Paria River? (Category A)

RIN 11.1.2 What are the historic properties within the area of potential effects? (Category A)

RIN 11.1.2.a For each tribe and living community, what are the register eligible traditional cultural properties? (Category A)

Sequence Order 4
(19 Information Needs)

RIN 1.1 What are the fundamental trophic interactions in the aquatic ecosystem? (Category A)

RIN 1.4 What is the current carbon budget for the Colorado River ecosystem? (Category A)

RIN 2.2.2 Determine if a population dynamics model can effectively predict response of native fish under different flow regimes and environmental conditions. (Category A)

RIN 2.2.6 What are the criteria for establishment of spawning aggregations (i.e., how does one determine if it is "established")? (Category A)

See page 1 for the key to the categories.

RIN 2.6.5 How are movement patterns for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem affected by age, natal stream, and dam operations? (Category A)

RIN 2.6.6 How is the rate of mortality for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem related to individual body size? What are the sources of mortality for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem? (Category A)

RIN 5.1.4 Identify and evaluate alternative Management Actions to ensure viability of Kanab ambersnail at Vasey's Paradise where (1) the population dynamic model predicts loss of population viability, or (2) monitoring discovers substantial habitat or Kanab ambersnail population declines. (Category A)

RIN 5.1.8 What are the measurable criteria that need to be met to remove jeopardy for Kanab ambersnail at Vasey's Paradise? (Category A)

RIN 6.4.1 How has the abundance, composition, and distribution of the sand beach community changed since dam closure (1963), high flows (1984), interim flows (1991), and the implementation of Record of Decision operations (1996)? (Category A)

RIN 6.5.3 How has the abundance and distribution of non-native species changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)? (Category A)

RIN 7.1.2 What are the most likely downstream temperature responses to a variety of scenarios involving a TCD on Glen Canyon Dam? (Category A)

RIN 7.2.3 Which metals should be measured? Where and how often? (Category A)

RIN 7.4.3 How do changes in flow volume and rate of change affect food base and energy productivity in the Colorado River ecosystem? (Category A)

RIN 8.5.1 What elements of Record of Decision operations (upramp, downramp, maximum and minimum flow, MLFF, HMF, and BHBF) are most/least critical to conserving new fine-sediment inputs, and stabilizing sediment deposits above the 25,000 cfs stage? (Category A)

SIN 8.5.3 What is the relationship between turbidity and biological processes? (Category A)

SIN 8.5.6 What are the grain-size characteristics of sand bars associated with designated riparian vegetation zones? (Category A)

RIN 11.1.1 What are the sources of impacts to historic properties? (Category A)

RIN 11.1.3.b How should adverse effects to historic properties be mitigated? (Category A)

RIN 11.2.3 Determine acceptable methods to preserve or treat traditionally important resources within the Colorado River ecosystem. (Category A)

Sequence Order 4.5
(17 Information Needs)

RIN 2.5.3 What characteristics define suitable habitat for razorback sucker? Does suitable habitat for razorback sucker occur in the Colorado River ecosystem? (Category A)

See page 1 for the key to the categories.

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RIN 2.6.4 What is the age structure, including relationship between age and size of flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem? (Category A)

RIN 4.1.3 To what extent is there overlap in the Lees Ferry reach of RBT habitat and native fish habitat? (Category A)

RIN 4.2.3 How is the rate of emigration of RBT from the Lees Ferry reach to below the Paria River affected by abundance, hydrology, temperature, and other ecosystem processes? (Category A)

RIN 4.2.5 To what extent is there overlap in the Colorado River ecosystem below the Paria River of RBT habitat and native fish habitat? (Category A)

RIN 6.2.1 How has the patch number, patch distribution, composition and area of the NHWZ community changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)? (Category A)

RIN 6.5.1 Determine if non-native species are expanding or contracting at a local scale (patch or reach). (Category A)

SIN 7.2.2 Which water quality variables influence food base and fisheries in the Colorado River ecosystem? (Category A)

IN 8.1 If sediment cannot be preserved in the system using available management actions, what is the feasibility (including technical, legal, economic, and policy issues) of sediment augmentation as a means of achieving this goal? (Category A)

SIN 8.5.4 What is the role of turbidity and how can it be managed to achieve biological objectives? (Category A)

RIN 8.6.2 How do ongoing inputs of coarse-sediment from tributaries alter the distribution of main channel habitats needed by benthic organisms within pools, runs, and eddies throughout the Colorado River ecosystem? (Category A)

RIN 11.2.1 What are traditionally important resources and locations for each tribe and other groups? (Category A)

RIN 11.2.2 What is the baseline measure for resource integrity? (Category A)

IN 12.2 Determine what information is necessary and sufficient to make recommendations at an acceptable level of risk. (Category A)

RIN 12.3.1 What are the most effective method(s) to integrate and synthesize resource data to increase our understanding of the past and for ongoing interactions of humans with the Colorado River ecosystem. (Category A)

RIN 12.5.5 Identify the desired level of information, education, and outreach provided for Glen and Grand Canyon river users and the general public. (Category A)

RIN 12.11.1 What are the most effective methods to maintain or attain the participation of externally funded investigators? (Category A)

Sequence Order 5
(53 Information Needs)

RIN 1.2 How are the production, composition, density, and biomass of the benthic invertebrate community affected by primary productivity vs. allochthonous inputs? (Category A)

See page 1 for the key to the categories.

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As approved by AMWG on August 13, 2003

RIN 1.3 What foodbase criteria do other agencies use to assess aquatic ecosystem health? (Category A)

RIN 1.1.1 How are the composition and biomass of primary producers between Glen Canyon Dam and the Paria River affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors. (Category A)

RIN 1.1.4 What are the habitat characteristics between Glen Canyon Dam and the Paria River that most affect primary productivity? How are these characteristics affected by Glen Canyon Dam operations? (Category A)

RIN 1.2.1 How are the composition and biomass of benthic invertebrates between Glen Canyon Dam and the Paria River affected by flow, water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), new invasive species, and water borne diseases, or other factors? (Category A)

RIN 1.2.2 What is the estimated productivity of benthic invertebrates for the reach between Glen Canyon Dam and the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.] (Category A)

RIN 1.4.1 How are the composition and biomass of benthic invertebrates in the Colorado River ecosystem below the Paria River affected by flow, water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), new invasive species, and water borne diseases, or other factors? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.] (Category A)

RIN 1.5.2 How do top-down effects (grazing and predation) affect the abundance and composition of drift? (Category A)

RIN 2.6.7 How does temperature modification in the mainstem affect recruitment and mortality for flannelmouth sucker, bluehead sucker, and speckled dace originating from tributary spawning efforts? (Category A)

RIN 5.1.2 What parameters have the greatest influence on population viability of Kanab ambersnail at Vasey's Paradise (e.g., parasites, predation, discharges, habitat size, quality, and human use/visitation)? (Category A)

RIN 5.1.3 Develop a population dynamic model to predict Kanab ambersnail viability under different flows and environmental conditions. (Category A)

RIN 5.2.1 How does the size, quality, and recovery time of Kanab ambersnail habitat change following natural scours, or other events? (Category A)

IN 6.4 How much allochthonous material (e.g., leaf litter) is exchanged between the terrestrial and aquatic systems? (Category A)

RIN 6.1.1 How has the abundance, composition, distribution, and area of the marsh community changed since dam closure (1963), high flows (1984), interim flows (1991), and the implementation of Record of Decision operations (1996)? (Category A)

RIN 6.3.2 What dam operations (Category A), or other management actions (Category B), have the potential to maintain the OHWZ community at the current stage elevation, or establish the community at a lower stage elevation?

RIN 6.5.2 What dam operations (Category A), or other management actions (Category B), have the potential to increase or decrease the distribution and abundance of non-native species?

See page 1 for the key to the categories.

RIN 6.6.2 Which seeps and springs are culturally important or occupied by rare and endemic species? (Category A)

RIN 7.1.1 What are the desired ranges of spatial and temporal patterns of water temperatures for the Colorado River ecosystem? (Category A)

RIN 7.2.1 Which major ions should be measured? Where and how often? (Category A)

RIN 7.2.2 Which nutrients should be measured? Where and how often? (Category A)

SIN 7.2.1 How do the hydrodynamics and stratification of Lake Powell influence the food base or fisheries downstream? (Category A)

RIN 7.3.1 Develop simulation models for Lake Powell and the Colorado River to predict water quality conditions under various operating scenarios, supplant monitoring efforts, and elucidate understanding of the effects of dam operations, climate, and basin hydrology on Colorado River water quality.

RIN 7.4.2 What is the desired pattern of seasonal and annual flow dynamics associated with power plant operations, BHBFs, HMFs, or other flows to meet AMP Goals and Objectives? (Category A)

RIN 8.1.1 What is the longitudinal variability of fine-sediment inputs, by reach? (Category A)

RIN 8.1.2 What is the temporal variability of fine-sediment inputs, by reach? (Category A)

RIN 8.1.3 What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.] (Category A)

RIN 8.2.1 What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.] (Category A)

RIN 8.3.1 What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.] (Category A)

RIN 8.4.1 What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.] (Category A)

RIN 8.5.4 What is the significance of aeolian processes in terrestrial sandbar reworking? (Category A)

RIN 8.5.6 What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.] (Category A)

SIN 8.5.2 What is the relationship between the fine-sediment budget and turbidity? (Category A)

SIN 8.5.5 How can the ongoing fine sediment supply be managed to achieve sustainable habitats? (Category A)

RIN 9.3.1 What is the desired target level of camping beaches by reach? (Category A)

See page 1 for the key to the categories.

RIN 10.1.2. What would be the effects on the Colorado River ecosystem and marketable capacity and energy of increasing the upramp and downramp limit? (Category A)

RIN 10.1.3 What would be the effects on the Colorado River ecosystem and marketable capacity and energy of raising the maximum power plant flow limit above 25,000 cfs? (Category A)

RIN 10.3.1 What are the effects of providing financial exception criteria? (Category A)

RIN 11.1.1.a What and where are the geomorphic processes that link loss of site integrity with dam operations as opposed to dam existence or natural processes? (Category A)

RIN 11.1.1.b What are the terrace formation processes and how do dam operations affect current terrace formations processes? (Category A)

RIN 11.1.1.c Determine if and where dam operations cause accelerated erosion to historic properties. (Category A)

RIN 11.1.1.d What are the potential threats to historic properties relative to integrity and significance? (Category A)

RIN 11.1.2.b How do specific sites meet National Register Criteria for Evaluation? (Category A)

RIN 11.1.2.c Identify AMP activities that affect National Register eligible sites? (Category A)

RIN 11.1.3.a Determine the necessary information to assess resource integrity. (Category A)

RIN 11.2.4 What changes are occurring in cultural resource sites, and what are the causes of those changes? (Category A)

RIN 12.3.2 What are the differences between western science and tribal processes for design of studies and for gathering, analyzing, and interpreting data used in the adaptive management program? How well do research designs and workplans incorporate Tribal perspectives and values into the standard western science paradigm? Is it more beneficial to keep the perspective separated? (Category A)

RIN 12.3.3 How effective is the AMP in addressing the EIS statement "Long-term monitoring and research are … implemented to measure how well the selected alternative meets resource management objectives."? (Category A)

RIN 12.5.1 What are the most effective means to build AMP public support through effective public outreach? (Category A)

RIN 12.5.2 What are the most effective means to attain and maintain effective communication and coordination with other resource management programs in the Colorado River basin to ensure consideration of their values and perspectives into the AMP and vice versa? (Category A)

RIN 12.5.4 What is the most effective way to distribute information to our stakeholders and the public in a secure and accessible fashion? (Category A)

RIN 12.7.1 How effective are the current strategies to achieve tribal consultation? (Category A)

RIN 12.7.2 How well do the current strategies to achieve tribal consultation meet legal and AMP protocols? (Category A)

See page 1 for the key to the categories.

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RIN 12.8.1 How well does current tribal participation in the AMP research and long-term monitoring programs meet tribal needs and desires? (Category B)

Sequence Order 5.5
(*14 Information Needs*)

RIN 1.2.4 What are the habitat characteristics between Glen Canyon Dam and the Paria River that most affect benthic invertebrates? How are these characteristics affected by Glen Canyon Dam operations? (Category A)

RIN 1.3.1 How are the composition and biomass of primary producers in the Colorado River ecosystem below the Paria River affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors. (Category A)

RIN 1.4.3 How do top-down effects (grazing and predation) affect the abundance and composition of benthic invertebrates? (Category A)

RIN 1.5.1 How are the composition and biomass of drift in the Colorado River ecosystem affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors? (Category A)

RIN 4.2.4 What is the target population size of RBT appropriate for the Lees Ferry reach that limits downstream emigration? (Category A)

RIN 6.3.1 How has the abundance, composition, and distribution of the OHWZ community changed since dam closure (1963), high flows (1984), interim flows (1991), and the implementation of Record of Decision operations (1996)? (Category A)

RIN 6.7.5 What is the need, feasibility, and priority of maintaining habitat suitability for southwestern willow flycatcher in the Colorado River ecosystem? (Category A)

RIN 8.5.2 What is the reach-scale variability of fine-sediment storage throughout the main channel? (Category A)

RIN 8.5.5 What are the historic and ongoing longitudinal trends of fine-sediment storage, above 25,000 cfs? (Category A)

SIN 8.5.7 What are the limiting factors that regulate substrate availability and its distribution? (Category A)

RIN 9.4.1 Identify the elements of wilderness experience specific to the Colorado River ecosystem. (Category A)

RIN 10.1.4 What would be the effects on the Colorado River ecosystem and marketable capacity and energy of lowering the minimum flow limit below 5,000 cfs? (Category A)

RIN 11.1.2.d Identify NPS permitted activities that affect National Register eligible sites. (Category A)

RIN 11.1.5 What are appropriate strategies to preserve resource integrity? (Category A)

Sequence Order 6
(*15 Information Needs*)

RIN 1.1.3 How do top-down effects (grazing and predation) on primary producers affect food base productivity? (Category A)

See page 1 for the key to the categories.

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As approved by AMWG on August 13, 2003

RIN 1.2.3 How do top-down effects (grazing and predation) affect the abundance and composition of benthic invertebrates? (Category A)

RIN 1.3.3 How do top-down effects on primary producers (grazing and predation) affect food base productivity? (Category A)

RIN 1.3.4 What are the habitat characteristics in the Colorado River ecosystem below the Paria River that most affect primary productivity? How are these characteristics affected by Glen Canyon Dam operations? (Category A)

RIN 1.4.4 What are the habitat characteristics in the Colorado River ecosystem below the Paria River that most affect benthic invertebrates? How are these characteristics affected by Glen Canyon Dam operations? (Category A)

RIN 2.2.11 What are the impacts of current recreational activities on mortality, recruitment and the population size of humpback chub? (Category A)

RIN 2.6.3 What are the physical and biological characteristics of habitats that enhance recruitment of flannelmouth sucker, bluehead sucker, and speckled dace populations in the Colorado River ecosystem? (Category A)

IN 6.1 Develop GIS coverages of natural communities in the Colorado River ecosystem to use in identification of status and trends. (Category A)

IN 6.3 How is the abundance of vertebrate consumers affected by seasonal shifts in food base abundance in the Colorado River ecosystem? (Category A)

SIN 7.3.1 Measure appropriate water quality parameters to determine the influence of these parameters on biological resources in the Colorado River ecosystem. (Category A)

SIN 8.5.8 What is the total area of different aquatic habitat types (cobble, gravel, sand, talus, etc,) in the Colorado River ecosystem? (Category A)

SIN 8.5.9 How are sandbar textures related to cultural site stability? (Category A)

RIN 10.1.1 What would be the effects on the Colorado River ecosystem and marketable capacity and energy of increasing the daily fluctuation limit? (Category A)

RIN 10.4.1 What are the effects on the Colorado River ecosystem and marketable power and energy of increasing Automatic Generation Control at Glen Canyon Dam? (Category A)

RIN 12.5.3 To what extent does the public understand and support the GCDAMP? (Category A)

Sequence Order 6.5
(5 Information Needs)

RIN 5.1.1 What constitutes population viability for Kanab ambersnail at Vasey's Paradise? (Category A)

RIN 5.2.3 How can remote sensing technologies be used to less intrusively and more cost effectively characterize and monitor Kanab ambersnail habitat at Vasey's Paradise (vegetation type and distribution)? (Category A)

IN 6.2 Develop or adopt an existing ecological community classification system. The system should describe the composition and frequency of vascular plants. (Category A)

See page 1 for the key to the categories.

Information Needs in Sequence Order
As approved by AMWG on August 13, 2003

RIN 7.2.4 What are the water-borne pathogens that are a threat to human health? How should they be monitored? Where and how often? (Category A)

RIN 8.6.1 How do ongoing inputs of coarse-sediment from tributaries influence storage of fine sediment within pools, runs and eddies throughout the Colorado River ecosystem? (Category A)

Sequence Order 7
(2 Information Needs)

RIN 9.5.1 What effects do administrative trips, including research and monitoring activities have on recreational users? (Category A)

IN 10.1 Determine and track the impacts to power users from implementation of Record of Decision dam operations and segregate those effects from other causes such as changes in the power market. (Category A)

Sequence Order 7.5
(2 Information Needs)

RIN 7.3.1.a Determine the status and trends of chemical and biological components of water quality in Lake Powell as a function of regional hydrologic conditions and their relation to downstream releases. (Category A)

SIN 8.5.10 How are sandbar textures related to recreational site stability? (Category A)

Sequence Order 8
(6 Information Needs)

RIN 1.3.2 What is the estimated primary productivity in the Colorado River ecosystem below the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.] (Category A)

RIN 1.4.2 What is the estimated productivity of benthic invertebrates in the Colorado River ecosystem below the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.] (Category A)

RIN 2.5.4 What is the feasibility and advisability of augmenting razorback sucker in the Colorado River ecosystem to attain a viable population including technical/legal/policy constraints? (Category A)

RIN 6.7.1 What is the function of the Colorado River ecosystem as a migratory corridor for southwestern willow flycatcher? (Category A)

RIN 6.7.2 What is the foodbase that supports southwestern willow flycatcher and other terrestrial vertebrates? (Category A)

RIN 6.7.3 What constitutes suitable southwestern willow flycatcher habitat? (Category A)

Sequence Order 8.5
(1 Information Need)

RIN 6.6.3 How has the composition, abundance and distribution of seep and spring communities changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)? (Category A)

See page 1 for the key to the categories.

Information Needs in Sequence Order
As approved by AMWG on August 13, 2003

Sequence Order 9
(*9 Information Needs*)

RIN 1.1.2 What is the estimated productivity for the reach between Glen Canyon Dam and the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.] (Category A)

RIN 2.5.5 What are the genetic and ecological criteria for reintroducing razorback sucker into the Colorado River ecosystem? (Category A)

RIN 4.1.2 What is the minimum quantity and quality of spawning substrate necessary for maintaining a wild reproducing rainbow trout population in the Lees Ferry reach? (Category A)

RIN 5.1.7 What is the historic range of Oxyloma haydeni? Can this range be determined from subfossil or fossil evidence? [NOTE: This is intended to determine if this is a relict species and the initial work would be done at Vasey's Paradise, South Canyon and other probable sites within the Colorado River ecosystem.] (Category C)

RIN 6.6.1 How is seep and spring habitat affected by variation in dam operations, variation in seep or spring flow, and variation in water quality? How do flow rates and water quality parameters at seeps and springs compare with historic measurements? (Category A)

RIN 6.6.4 What is the distribution, patch size, total area, and composition of seep and spring communities and the flow rate and water quality of all seeps and springs within the Colorado River ecosystem? (Category A)

RIN 6.7.4 How has the abundance, distribution and reproductive success of southwestern willow flycatcher changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)? (Category A)

RIN 7.3.3 How do dam operations affect reservoir limnology? (Category A)

SIN 8.5.1 How do sandbar textures influence biological processes? (Category A)

Sequence Order 9.5
(*2 Information Needs*)

RIN 3.1.1 What information (including technical, legal, economic, and policy issues) should be considered in determining the feasibility and advisability of restoring pikeminnow, bonytail, roundtail chub, river otter, or other extirpated species? (Category C)

RIN 8.5.3 What is the pre- and post-dam range of grain-size in fine-sediment deposits, by reach? (Category A)

Sequence Order 10
(*2 Information Needs*)

RIN 4.1.1 What is the target proportional stock density (i.e., trade-off between numbers and size) for rainbow trout in the Lees Ferry reach? (Category A)

RIN 4.1.4 How does the genetics or "strain" of rainbow trout in the Lees Ferry reach influence the average size of fish creeled by anglers? (Category A)

Sequence Order 10.5
(*0 Information Needs*)

See page 1 for the key to the categories.

Information Needs in Sequence Order
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Sequence Order 11
(*9 Information Needs*)

RIN 2.5.1 If razorback suckers were stocked into the Colorado River ecosystem, what is the risk that hybridization with flannelmouth suckers would compromise the genetic integrity of either species? (Category A)

RIN 2.5.2 How does existing hybridization between razorback suckers and flannelmouth suckers affect the genetic integrity of either species? What are the factors contributing to this ongoing hybridization? (Category A)

RIN 2.5.6 What are the measurable criteria that would need to be met to remove jeopardy for razorback sucker in the Colorado River ecosystem? (Category C)

RIN 7.3.2 How accurately can modeling predict reservoir dynamics and operational scenarios? (Category A)

RIN 9.1.1 What are the attributes of a quality river experience? (How do you define a quality river experience?) (Category A)

RIN 9.1.2 Determine the appropriate carrying capacity for recreational activities within the Colorado River ecosystem. (Category A)

RIN 9.1.3 How do ongoing inputs of coarse-sediment from tributaries diminish or enhance navigability of rapids throughout the Colorado River ecosystem? (Category A)

RIN 12.1.2 What are the use (e.g., hydropower, trout fishing, rafting) and non-use (e.g., option, vicarious, quasi-option, bequest and existence) values of the Colorado River ecosystem? (Category A)

RIN 12.1.3 How does use (e.g., hydropower, trout fishing, rafting) and non-use (e.g., option, vicarious, quasi-option, bequest and existence) values change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action? (Category A)

Sequence Order 11.5
(*4 Information Needs*)

RIN 7.3.1.b Determine stratification, convective mixing patterns, and behavior of advective currents in Lake Powell and their relation to Glen Canyon Dam operations to predict seasonal patterns and trends in downstream releases. (Category A)

RIN 7.4.1 What is the desired range of seasonal and annual flow dynamics associated with powerplant operations, BHBFs, and habitat maintenance flows, or other flows that meet AMP goals and objectives? (Category A)

RIN 10.1.5 How do power-marketing contract provisions affect Glen Canyon Dam releases? (Category A)

RIN 12.1.1 What is the economic value of the recreational use of the Colorado River ecosystem downstream from Glen Canyon Dam? (Category A)

See page 1 for the key to the categories.

<table>
<tr><td colspan="2" align="center"><i>Information Needs Organized by Goal
Showing Sequence Order and Category
As approved by AMWG on August 13, 2003</i></td></tr>
</table>

Goal 1 Protect or improve the aquatic foodbase so that it will support viable populations of desired species at higher trophic levels.	*Sequence Order / Category*
RIN 1.1 What are the fundamental trophic interactions in the aquatic ecosystem?	4 / A
RIN 1.2 How are the production, composition, density, and biomass of the benthic invertebrate community affected by primary productivity vs. allochthonous inputs?	5 / A
RIN 1.3 What foodbase criteria do other agencies use to assess aquatic ecosystem health?	5 / A
RIN 1.4 What is the current carbon budget for the Colorado River ecosystem?	4 / A
RIN 1.1.1 How are the composition and biomass of primary producers between Glen Canyon Dam and the Paria River affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors.	5 / A
RIN 1.1.2 What is the estimated productivity for the reach between Glen Canyon Dam and the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.]	9 / A
RIN 1.1.3 How do top-down effects (grazing and predation) on primary producers affect food base productivity?	6 / A
RIN 1.1.4 What are the habitat characteristics between Glen Canyon Dam and the Paria River that most affect primary productivity? How are these characteristics affected by Glen Canyon Dam operations?	5 / A
RIN 1.2.1 How are the composition and biomass of benthic invertebrates between Glen Canyon Dam and the Paria River affected by flow, water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), new invasive species, and water borne diseases, or other factors?	5 / A
RIN 1.2.2 What is the estimated productivity of benthic invertebrates for the reach between Glen Canyon Dam and the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.]	5 / A
RIN 1.2.3 How do top-down effects (grazing and predation) affect the abundance and composition of benthic invertebrates?	6 / A
RIN 1.2.4 What are the habitat characteristics between Glen Canyon Dam and the Paria River that most affect benthic invertebrates? How are these characteristics affected by Glen Canyon Dam operations?	5.5 / A
RIN 1.3.1 How are the composition and biomass of primary producers in the Colorado River ecosystem below the Paria River affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors.	5.5 / A

See page 1 for the key to the categories.

RIN 1.3.2 What is the estimated primary productivity in the Colorado River ecosystem below the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.]	8 / A
RIN 1.3.3 How do top-down effects on primary producers (grazing and predation) affect food base productivity?	6 / A
RIN 1.3.4 What are the habitat characteristics in the Colorado River ecosystem below the Paria River that most affect primary productivity? How are these characteristics affected by Glen Canyon Dam operations?	6 / A
RIN 1.4.1 How are the composition and biomass of benthic invertebrates in the Colorado River ecosystem below the Paria River affected by flow, water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), new invasive species, and water borne diseases, or other factors? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.]	5 / A
RIN 1.4.2 What is the estimated productivity of benthic invertebrates in the Colorado River ecosystem below the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.]	8 / A
RIN 1.4.3 How do top-down effects (grazing and predation) affect the abundance and composition of benthic invertebrates?	5.5 / A
RIN 1.4.4 What are the habitat characteristics in the Colorado River ecosystem below the Paria River that most affect benthic invertebrates? How are these characteristics affected by Glen Canyon Dam operations?	6 / A
RIN 1.5.1 How are the composition and biomass of drift in the Colorado River ecosystem affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors?	5.5 / A
RIN 1.5.2 How do top-down effects (grazing and predation) affect the abundance and composition of drift?	5 / A
RIN 1.5.3 How has the value and availability of drift as a food source for Humpback chub changed with the implementation of Record of Decision operations?	3 / A
Goal 2 Maintain or attain viable populations of existing native fish, remove jeopardy from humpback chub and razorback sucker, and prevent adverse modification to their critical habitat.	*Sequence Order / Category*
RIN 2.1.1 What is the minimum population size of HBC that should be sustained in the LCR, to ensure a viable spawning population of HBC in the LCR?	2.5 / A

See page 1 for the key to the categories.

RIN 2.1.2 Quantify sources of mortality for humpback chub < 51 mm in rearing habitats in the LCR and mainstem and how these sources of mortality are related to dam operations.	1 / A
RIN 2.1.3 What is the relationship between size of HBC and mortality in the LCR and the mainstem? What are the sources of mortality (i.e., predation, cannibalism, other) in the LCR and the mainstem?	1.5 / A
RIN 2.1.4 What habitats enhance recruitment of native fish in the LCR and mainstem? What are the physical and biological characteristics of those habitats?	2 / A
RIN 2.1.5 Determine the timing and quantity of young-of-year humpback chub dispersal (passive and active) from the LCR.	2 / A
RIN 2.2.1 What is a viable population and what is the appropriate method to assess population viability of native fish in the Colorado River ecosystem? What is an acceptable probability of extinction over what management time period for humpback chub throughout the Colorado River ecosystem?	3.5 / A
RIN 2.2.2 Determine if a population dynamics model can effectively predict response of native fish under different flow regimes and environmental conditions.	4 / A
RIN 2.2.3 What are the measurable criteria that need to be met in order to remove jeopardy for humpback chub in the Colorado River ecosystem?	2 / C
RIN 2.2.4 What is the relationship between the "aggregations" in the mainstem and LCR? Are mainstem aggregations "sinks" of the LCR? Are aggregations real or due to sampling bias?	2.5 / A
RIN 2.2.5 What are the appropriate habitat conditions for HBC spawning? Where are these found? Can they be created in the mainstem?	2 / A
RIN 2.2.6 What are the criteria for establishment of spawning aggregations (i.e., how does one determine if it is "established")?	4 / A
RIN 2.2.7 Determine if implementation and operation of the TCD and/or steady flows represent a technically feasible, ecologically sustainable, and practical option for establishing mainstem spawning.	3 / A
RIN 2.2.8 What combination of dam release patterns and non-native fish control facilitates successful spawning and recruitment of humpback chub in the Colorado River ecosystem?	2 / A
RIN 2.2.9 What is the appropriate role of humpback chub augmentation as a management strategy to establish mainstem spawning aggregations?	2 / A
RIN 2.2.10 What techniques are available to determine natal stream of fishes in the Colorado River ecosystem?	3 / A
RIN 2.2.11 What are the impacts of current recreational activities on mortality, recruitment and the population size of humpback chub?	6 / A

See page 1 for the key to the categories.

RIN 2.2.12 What are the impacts of research activities on mortality, recruitment, and the population size of humpback chub?	3 / A
RIN 2.3.1 How do parasite/disease loads affect population viability?	3 / A
RIN 2.3.2 How will warming mainstem temperatures affect the abundance and distribution of parasites/disease?	2 / A
RIN 2.3.3 How does non-native fish control affect disease/parasite loads? [Note: The concept is if there are fewer hosts, there will be a lower incidence of parasites.]	3.5 / A
RIN 2.4.1 What are the most effective strategies and control methods to limit non-native fish predation and competition on native fish?	2 / A
RIN 2.4.2 Determine if suppression of non-native predators and competitors increases native fish populations.	2.5 / A
RIN 2.4.3 To what degree, which species, and where in the system are exotic fish a detriment to the existence of native fish through predation or competition?	2 / A
RIN 2.4.4 What are the target population levels, body size and age structure for non-native fish in the Colorado River ecosystem that limit their levels to those commensurate with the viability of native fish populations?	3 / A
RIN 2.4.5 What are the sources (natal stream) of nonnative predators and competitors?	3 / A
RIN 2.4.6 What are the population dynamics of those non-native fish that are the major predators and competitors of native fish?	2.5 / A
RIN 2.5.1 If razorback suckers were stocked into the Colorado River ecosystem, what is the risk that hybridization with flannelmouth suckers would compromise the genetic integrity of either species?	11 / A
RIN 2.5.2 How does existing hybridization between razorback suckers and flannelmouth suckers affect the genetic integrity of either species? What are the factors contributing to this ongoing hybridization?	11 / A
RIN 2.5.3 What characteristics define suitable habitat for razorback sucker? Does suitable habitat for razorback sucker occur in the Colorado River ecosystem?	4.5 / A
RIN 2.5.4 What is the feasibility and advisability of augmenting razorback sucker in the Colorado River ecosystem to attain a viable population including technical/legal/policy constraints?	8 / A
RIN 2.5.5 What are the genetic and ecological criteria for reintroducing razorback sucker into the Colorado River ecosystem?	9 / A
RIN 2.5.6 What are the measurable criteria that would need to be met to remove jeopardy for razorback sucker in the Colorado River ecosystem?	11 / C

See page 1 for the key to the categories.

	Sequence Order / Category
RIN 2.6.1 What is a viable population (flannelmouth sucker, bluehead sucker and speckled dace)?	2 / C
RIN 2.6.2 What are the significant threats to these species (flannelmouth sucker, bluehead sucker and speckled dace)?	2 / A
RIN 2.6.3 What are the physical and biological characteristics of habitats that enhance recruitment of flannelmouth sucker, bluehead sucker, and speckled dace populations in the Colorado River ecosystem?	6 / A
RIN 2.6.4 What is the age structure, including relationship between age and size of flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem?	4.5 / A
RIN 2.6.5 How are movement patterns for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem affected by age, natal stream, and dam operations?	4 / A
RIN 2.6.6 How is the rate of mortality for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem related to individual body size? What are the sources of mortality for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem?	4 / A
RIN 2.6.7 How does temperature modification in the mainstem affect recruitment and mortality for flannelmouth sucker, bluehead sucker, and speckled dace originating from tributary spawning efforts?	5 / A
Goal 3 Restore populations of extirpated species, as feasible and advisable.	*Sequence Order / Category*
RIN 3.1.1 What information (including technical, legal, economic, and policy issues) should be considered in determining the feasibility and advisability of restoring pikeminnow, bonytail, roundtail chub, river otter, or other extirpated species?	9.5 / C
Goal 4 Maintain a naturally reproducing population of rainbow trout above the Paria River, to the extent practicable and consistent with the maintenance of viable populations of native fish.	*Sequence Order / Category*
RIN 4.1.1 What is the target proportional stock density (i.e., trade-off between numbers and size) for rainbow trout in the Lees Ferry reach?	10 / A
RIN 4.1.2 What is the minimum quantity and quality of spawning substrate necessary for maintaining a wild reproducing rainbow trout population in the Lees Ferry reach?	9 / A
RIN 4.1.3 To what extent is there overlap in the Lees Ferry reach of RBT habitat and native fish habitat?	4.5 / A
RIN 4.1.4 How does the genetics or "strain" of rainbow trout in the Lees Ferry reach influence the average size of fish creeled by anglers?	10 / A

See page 1 for the key to the categories.

Information Needs Organized by Goal Showing Sequence Order and Category As approved by AMWG on August 13, 2003	
RIN 4.2.1 What is the rate of emigration of rainbow trout from the Lees Ferry reach?	2.5 / A
RIN 4.2.2 What is the most effective method to detect emigration of rainbow trout from the Lees Ferry reach?	2.5 / A
RIN 4.2.3 How is the rate of emigration of RBT from the Lees Ferry reach to below the Paria River affected by abundance, hydrology, temperature, and other ecosystem processes?	4.5 / A
RIN 4.2.4 What is the target population size of RBT appropriate for the Lees Ferry reach that limits downstream emigration?	5.5 / A
RIN 4.2.5 To what extent is there overlap in the Colorado River ecosystem below the Paria River of RBT habitat and native fish habitat?	4.5 / A
RIN 4.2.6 To what extent are RBT below the Paria River predators of native fish, primarily HBC? At what size do they become predators of native fish, especially HBC, i.e. how do the trophic interactions between RBT and native fish change with size of fish?	2 / A
RIN 4.2.7 What dam release patterns most effectively maintain the Lees Ferry RBT trophy fishery while limiting RBT survival below the Paria River?	3.5 / A
Goal 5 Maintain or attain viable populations of Kanab ambersnail.	*Sequence Order / Category*
RIN 5.1.1 What constitutes population viability for Kanab ambersnail at Vasey's Paradise?	6.5 / A
RIN 5.1.2 What parameters have the greatest influence on population viability of Kanab ambersnail at Vasey's Paradise (e.g., parasites, predation, discharges, habitat size, quality, and human use/visitation)?	5 / A
RIN 5.1.3 Develop a population dynamic model to predict Kanab ambersnail viability under different flows and environmental conditions.	5 / A
RIN 5.1.4 Identify and evaluate alternative Management Actions to ensure viability of Kanab ambersnail at Vasey's Paradise where (1) the population dynamic model predicts loss of population viability, or (2) monitoring discovers substantial habitat or Kanab ambersnail population declines.	4 / A
RIN 5.1.5 What is the taxonomic identity of the Oxyloma snails at Vasey's Paradise? Is a change to the existing taxonomic status warranted?	2.5 / C
RIN 5.1.6 What is the range of occurrence of the ambersnail taxon found at Vasey's Paradise? [NOTE: Intended to address the issue of whether this is an endemic population or a relict population or part of a metapopulation.]	2.5 / C

See page 1 for the key to the categories.

Information Needs Organized by Goal Showing Sequence Order and Category As approved by AMWG on August 13, 2003	
RIN 5.1.7 What is the historic range of Oxyloma haydeni? Can this range be determined from subfossil or fossil evidence? [NOTE: This is intended to determine if this is a relict species and the initial work would be done at Vasey's Paradise, South Canyon and other probable sites within the Colorado River ecosystem.]	9 / C
RIN 5.1.8 What are the measurable criteria that need to be met to remove jeopardy for Kanab ambersnail at Vasey's Paradise?	4 / A
RIN 5.1.9 How can incidental take for Kanab ambersnail at Vasey's Paradise be minimized?	3 / A
RIN 5.2.1 How does the size, quality, and recovery time of Kanab ambersnail habitat change following natural scours, or other events?	5 / A
RIN 5.2.2 How does the size and quality of the habitat used by Kanab ambersnail change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?	2 / A
RIN 5.2.3 How can remote sensing technologies be used to less intrusively and more cost effectively characterize and monitor Kanab ambersnail habitat at Vasey's Paradise (vegetation type and distribution)?	6.5 / A
Goal 6 Protect or improve the biotic riparian and spring communities including threatened and endangered species and their critical habitat.	*Sequence Order / Category*
IN 6.1 Develop GIS coverages of natural communities in the Colorado River ecosystem to use in identification of status and trends.	6 / A
IN 6.2 Develop or adopt an existing ecological community classification system. The system should describe the composition and frequency of vascular plants, vertebrates, arthropods, and mollusks to an appropriate taxonomic level.	6.5 / A
IN 6.3 How is the abundance of vertebrate consumers affected by seasonal shifts in food base abundance in the Colorado River ecosystem?	6 / A
IN 6.4 How much allochthonous material (e.g., leaf litter) is exchanged between the terrestrial and aquatic systems?	5 / A
RIN 6.1.1 How has the abundance, composition, distribution, and area of the marsh community changed since dam closure (1963), high flows (1984), interim flows (1991), and the implementation of Record of Decision operations (1996)?	5 / A
RIN 6.2.1 How has the patch number, patch distribution, composition and area of the NHWZ community changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)?	4.5 / A

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Information Needs Organized by Goal Showing Sequence Order and Category As approved by AMWG on August 13, 2003	
RIN 6.3.1 How has the abundance, composition, and distribution of the OHWZ community changed since dam closure (1963), high flows (1984), interim flows (1991), and the implementation of Record of Decision operations (1996)?	5.5 / A
RIN 6.3.2 What dam operations (Category A), or other management actions (Category B), have the potential to maintain the OHWZ community at the current stage elevation, or establish the community at a lower stage elevation?	5 / A and B
RIN 6.4.1 How has the abundance, composition, and distribution of the sand beach community changed since dam closure (1963), high flows (1984), interim flows (1991), and the implementation of Record of Decision operations (1996)?	4 / A
RIN 6.5.1 Determine if non-native species are expanding or contracting at a local scale (patch or reach).	4.5 / A
RIN 6.5.2 What dam operations (Category A), or other management actions (Category B), have the potential to increase or decrease the distribution and abundance of non-native species?	5 / A or B
RIN 6.5.3 How has the abundance and distribution of non-native species changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)?	4 / A
RIN 6.6.1 How is seep and spring habitat affected by variation in dam operations, variation in seep or spring flow, and variation in water quality? How do flow rates and water quality parameters at seeps and springs compare with historic measurements?	9 / A
RIN 6.6.2 Which seeps and springs are culturally important or occupied by rare and endemic species?	5 / A
RIN 6.6.3 How has the composition, abundance and distribution of seep and spring communities changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)?	8.5 / A
RIN 6.6.4 What is the distribution, patch size, total area, and composition of seep and spring communities and the flow rate and water quality of all seeps and springs within the Colorado River ecosystem?	9 / A
RIN 6.7.1 What is the function of the Colorado River ecosystem as a migratory corridor for southwestern willow flycatcher?	8 / A
RIN 6.7.2 What is the foodbase that supports southwestern willow flycatcher and other terrestrial vertebrates?	8 / A
RIN 6.7.3 What constitutes suitable southwestern willow flycatcher habitat?	8 / A
RIN 6.7.4 How has the abundance, distribution and reproductive success of southwestern willow flycatcher changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)?	9 / A

See page 1 for the key to the categories.

Information Needs Organized by Goal Showing Sequence Order and Category As approved by AMWG on August 13, 2003	
RIN 6.7.5 What is the need, feasibility, and priority of maintaining habitat suitability for southwestern willow flycatcher in the Colorado River ecosystem?	5.5 / A
Goal 7 Establish water temperature, quality, and flow dynamics to achieve the Adaptive Management Program ecosystem goals.	*Sequence Order / Category*
RIN 7.1.1 What are the desired ranges of spatial and temporal patterns of water temperatures for the Colorado River ecosystem?	5 / A
RIN 7.1.2 What are the most likely downstream temperature responses to a variety of scenarios involving a TCD on Glen Canyon Dam?	4 / A
RIN 7.1.3 What are the potential ecological effects of increasing mainstem water temperatures?	3 / A
RIN 7.2.1 Which major ions should be measured? Where and how often?	5 / A
RIN 7.2.2 Which nutrients should be measured? Where and how often?	5 / A
RIN 7.2.3 Which metals should be measured? Where and how often?	4 / A
RIN 7.2.4 What are the water-borne pathogens that are a threat to human health? How should they be monitored? Where and how often?	6.5 / A
SIN 7.2.1 How do the hydrodynamics and stratification of Lake Powell influence the food base or fisheries downstream?	5 / A
SIN 7.2.2 Which water quality variables influence food base and fisheries in the Colorado River ecosystem?	4.5 / A
RIN 7.3.1 Develop simulation models for Lake Powell and the Colorado River to predict water quality conditions under various operating scenarios, supplant monitoring efforts, and elucidate understanding of the effects of dam operations, climate, and basin hydrology on Colorado River water quality.	5 / A
RIN 7.3.1.a Determine the status and trends of chemical and biological components of water quality in Lake Powell as a function of regional hydrologic conditions and their relation to downstream releases.	7.5 / A
RIN 7.3.1.b Determine stratification, convective mixing patterns, and behavior of advective currents in Lake Powell and their relation to Glen Canyon Dam operations to predict seasonal patterns and trends in downstream releases.	11.5 / A
RIN 7.3.2 How accurately can modeling predict reservoir dynamics and operational scenarios?	11 / A
RIN 7.3.3 How do dam operations affect reservoir limnology?	9 / A

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Information Needs Organized by Goal Showing Sequence Order and Category As approved by AMWG on August 13, 2003	
SIN 7.3.1 Measure appropriate water quality parameters to determine the influence of these parameters on biological resources in the Colorado River ecosystem.	6 / A
RIN 7.4.1 What is the desired range of seasonal and annual flow dynamics associated with powerplant operations, BHBFs, and habitat maintenance flows, or other flows that meet AMP goals and objectives?	11.5 / A
RIN 7.4.2 What is the desired pattern of seasonal and annual flow dynamics associated with powerplant operations, BHBFs, HMFs, or other flows to meet AMP Goals and Objectives?	5 / A
RIN 7.4.3 How do changes in flow volume and rate of change affect food base and energy productivity in the Colorado River ecosystem?	4 / A
RIN 7.4.4 How does flow rate and fluctuation affect habitat availability and utilization by fish and other organisms?	3 / A
Goal 8 Maintain or attain levels of sediment storage within the main channel and along shorelines to achieve the Adaptive Management Program ecosystem goals.	*Sequence Order / Category*
IN 8.1 If sediment cannot be preserved in the system using available management actions, what is the feasibility (including technical, legal, economic, and policy issues) of sediment augmentation as a means of achieving this goal?	4.5 / A
RIN 8.1.1 What is the longitudinal variability of fine-sediment inputs, by reach?	5 / A
RIN 8.1.2 What is the temporal variability of fine-sediment inputs, by reach?	5 / A
RIN 8.1.3 What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.]	5 / A
RIN 8.2.1 What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.]	5 / A
RIN 8.3.1 What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.]	5 / A
RIN 8.4.1 What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.]	5 / A
RIN 8.5.1 What elements of Record of Decision operations (upramp, downramp, maximum and minimum flow, MLFF, HMF, and BHBF) are most/least critical to conserving new fine-sediment inputs, and stabilizing sediment deposits above the 25,000 cfs stage?	4 / A

See page 1 for the key to the categories.

Information Needs Organized by Goal Showing Sequence Order and Category As approved by AMWG on August 13, 2003	
RIN 8.5.2 What is the reach-scale variability of fine-sediment storage throughout the main channel?	5.5 / A
RIN 8.5.3 What is the pre- and post-dam range of grain-size in fine-sediment deposits, by reach?	9.5 / A
RIN 8.5.4 What is the significance of aeolian processes in terrestrial sandbar reworking?	5 / A
RIN 8.5.5 What are the historic and ongoing longitudinal trends of fine-sediment storage, above 25,000 cfs?	5.5 / A
RIN 8.5.6 What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.]	5 / A
SIN 8.5.1 How do sandbar textures influence biological processes?	9 / A
SIN 8.5.2 What is the relationship between the fine-sediment budget and turbidity?	5 / A
SIN 8.5.3 What is the relationship between turbidity and biological processes?	4 / A
SIN 8.5.4 What is the role of turbidity and how can it be managed to achieve biological objectives?	4.5 / A
SIN 8.5.5 How can the ongoing fine sediment supply be managed to achieve sustainable habitats?	5 / A
SIN 8.5.6 What are the grain-size characteristics of sand bars associated with designated riparian vegetation zones?	4 / A
SIN 8.5.7 What are the limiting factors that regulate substrate availability and its distribution?	5.5 / A
SIN 8.5.8 What is the total area of different aquatic habitat types (cobble, gravel, sand, talus, etc,) in the Colorado River ecosystem?	6 / A
SIN 8.5.9 How are sandbar textures related to cultural site stability?	6 / A
SIN 8.5.10 How are sandbar textures related to recreational site stability?	7.5 / A
RIN 8.6.1 How do ongoing inputs of coarse-sediment from tributaries influence storage of fine sediment within pools, runs and eddies throughout the Colorado River ecosystem?	6.5 / A
RIN 8.6.2 How do ongoing inputs of coarse-sediment from tributaries alter the distribution of main channel habitats needed by benthic organisms within pools, runs, and eddies throughout the Colorado River ecosystem?	4.5 / A

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Information Needs Organized by Goal Showing Sequence Order and Category As approved by AMWG on August 13, 2003	
Goal 9 Maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of the Adaptive Management Program ecosystem goals.	*Sequence Order / Category*
RIN 9.1.1 What are the attributes of a quality river experience? (How do you define a quality river experience?)	11 / A
RIN 9.1.2 Determine the appropriate carrying capacity for recreational activities within the Colorado River ecosystem.	11 / A
RIN 9.1.3 How do ongoing inputs of coarse-sediment from tributaries diminish or enhance navigability of rapids throughout the Colorado River ecosystem?	11 / A
RIN 9.3.1 What is the desired target level of camping beaches by reach?	5 / A
RIN 9.4.1 Identify the elements of wilderness experience specific to the Colorado River ecosystem.	5.5 / A
RIN 9.5.1 What effects do administrative trips, including research and monitoring activities have on recreational users?	7 / A
Goal 10 Maintain power production capacity and energy generation, and increase where feasible and advisable, within the framework of the Adaptive Management ecosystem goals.	*Sequence Order / Category*
IN 10.1 Determine and track the impacts to power users from implementation of Record of Decision dam operations and segregate those effects from other causes such as changes in the power market.	7 / A
RIN 10.1.1 What would be the effects on the Colorado River ecosystem and marketable capacity and energy of increasing the daily fluctuation limit?	6 / A
RIN 10.1.2 What would be the effects on the Colorado River ecosystem and marketable capacity and energy of increasing the upramp and downramp limit?	5 / A
RIN 10.1.3 What would be the effects on the Colorado River ecosystem and marketable capacity and energy of raising the maximum power plant flow limit above 25,000 cfs?	5 / A
RIN 10.1.4 What would be the effects on the Colorado River ecosystem and marketable capacity and energy of lowering the minimum flow limit below 5,000 cfs?	5.5 / A
RIN 10.1.5 How do power-marketing contract provisions affect Glen Canyon Dam releases?	11.5 / A
RIN 10.3.1 What are the effects of providing financial exception criteria?	5 / A

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RIN 10.4.1 What are the effects on the Colorado River ecosystem and marketable power and energy of increasing Automatic Generation Control at Glen Canyon Dam?	6 / A
Goal 11 Preserve, protect, manage, and treat cultural resources for the inspiration and benefit of past, present, and future generations.	*Sequence Order / Category*
RIN 11.1.1 What are the sources of impacts to historic properties?	4 / A
RIN 11.1.1.a What and where are the geomorphic processes that link loss of site integrity with dam operations as opposed to dam existence or natural processes?	5 / A
RIN 11.1.1.b What are the terrace formation processes and how do dam operations affect current terrace formations processes?	5 / A
RIN 11.1.1.c Determine if and where dam operations cause accelerated erosion to historic properties.	5 / A
RIN 11.1.1.d What are the potential threats to historic properties relative to integrity and significance?	5 / A
RIN 11.1.2 What are the historic properties within the area of potential effects?	3.5 / A
RIN 11.1.2.a For each tribe and living community, what are the register eligible traditional cultural properties?	3.5 / A
RIN 11.1.2.b How do specific sites meet National Register Criteria for Evaluation?	5 / A
RIN 11.1.2.c Identify AMP activities that affect National Register eligible sites.	5 / A
RIN 11.1.2.d Identify NPS permitted activities that affect National Register eligible sites.	5.5 / A
RIN 11.1.3 What are the thresholds triggering management actions?	3 / A
RIN 11.1.3.a Determine the necessary information to assess resource integrity.	5 / A
RIN 11.1.3.b How should adverse effects to historic properties be mitigated?	4 / A
RIN 11.1.5 What are appropriate strategies to preserve resource integrity?	5.5 / A
RIN 11.2.1 What are traditionally important resources and locations for each tribe and other groups?	4.5 / A
RIN 11.2.2 What is the baseline measure for resource integrity?	4.5 / A
RIN 11.2.3 Determine acceptable methods to preserve or treat traditionally important resources within the Colorado River ecosystem.	4 / A

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RIN 11.2.4 What changes are occurring in cultural resource sites, and what are the causes of those changes?	5 / A
Goal 12 Maintain a high quality monitoring, research, and adaptive management program.	*Sequence Order / Category*
IN 12.1 Develop information that can be used by the TWG, in collaboration with GCMRC, to establish current and target levels for all resources within the AMP as called for in the AMP strategic plan.	3 / A
IN 12.2 Determine what information is necessary and sufficient to make recommendations at an acceptable level of risk.	4.5 / A
RIN 12.1.1 What is the economic value of the recreational use of the Colorado River ecosystem downstream from Glen Canyon Dam?	11.5 / A
RIN 12.1.2 What are the use (e.g., hydropower, trout fishing, rafting) and non-use (e.g., option, vicarious, quasi-option, bequest and existence) values of the Colorado River ecosystem?	11 / A
RIN 12.1.3 How does use (e.g., hydropower, trout fishing, rafting) and non-use (e.g., option, vicarious, quasi-option, bequest and existence) values change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?	11 / A
RIN 12.3.1 As necessary, investigate the most effective methods to integrate and synthesize resource data.	4.5 / A
RIN 12.3.2 What are the differences between western science and tribal processes for design of studies and for gathering, analyzing, and interpreting data used in the adaptive management program? How well do research designs and workplans incorporate Tribal perspectives and values into the standard western science paradigm? Is it more beneficial to keep the perspective separated?	5 / A
RIN 12.3.3 How effective is the AMP in addressing the EIS statement "Long-term monitoring and research are … implemented to measure how well the selected alternative meets resource management objectives."?	5 / A
RIN 12.5.1 What are the most effective means to build AMP public support through effective public outreach?	5 / A
RIN 12.5.2 What are the most effective means to attain and maintain effective communication and coordination with other resource management programs in the Colorado River basin to ensure consideration of their values and perspectives into the AMP and vice versa?	5 / A
RIN 12.5.3 To what extent does the public understand and support the GCDAMP?	6 / A
RIN 12.5.4 What is the most effective way to distribute information to our stakeholders and the public in a secure and accessible fashion?	5 / A

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RIN 12.5.5 Identify the desired level of information, education, and outreach provided for Glen and Grand Canyon river users and the general public.	4.5 / A
RIN 12.7.1 How effective are the current strategies to achieve tribal consultation?	5 / A
RIN 12.7.2 How well do the current strategies to achieve tribal consultation meet legal and AMP protocols?	5 / A
RIN 12.8.1 How well does current tribal participation in the AMP research and long-term monitoring programs meet tribal needs and desires?	5 / B
RIN 12.9.1 What is the impact on downstream resources of short-term increases to maximum flow, daily fluctuations, and downramp limits?	3 / A
RIN 12.9.2 What is the best combination of dam operations and other management actions to achieve the vision, mission, goals, and objectives of the GCDAMP?	2 / A
RIN 12.9.3 What are the relationships between dam operations and other management actions in their effects on resources addressed by GCDAMP management objectives?	2 / A
RIN 12.11.1 What are the most effective methods to maintain or attain the participation of externally funded investigators?	4.5 / A

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